Halictus erythrurus, Cockerell.

♀.—York, W. Australia (*O. H. Sargent*).

The specimen has two large black marks on the fifth abdominal segment, sublateral and lateral spots on the fourth, and lateral spots on the third. I have a specimen from the type-locality with lateral spots on the abdomen, so the peculiarity can hardly indicate a subspecies.

Halictus melanurus, sp. n.

♀.—Length about 4 mm.

Black, with the abdomen about as far as middle of third segment shining yellowish-ferruginous, beyond that very dark fuscous, almost black, basal half of first segment also dusky; labrum and mandibles except apex dark red; flagellum clear ferruginous beneath except at base; tegulæ clear ferruginous. Legs dusky red, with the anterior tibiæ in front and all the knees clear red; pubescence scanty, dull white. Abdomen without hair-bands. Wings clear, stigma and nervures ferruginous; outer r. n. and t.-c. much weakened; first r. n. meeting second t.-c. Head ordinary, face broad; clypeus shining; front dull; mesothorax moderately shining, very finely punctured; area of metathorax rough, with delicate plicæ, the margin shining. Microscopical characters:—Front densely punctured, the surface between the punctures finely sculptured; mesothorax microscopically tessellate, anteriorly transversely lineolate; area of metathorax with wrinkled plicæ; hind spur of the simple type (microscopically serrulate or spinulose).

York, W. Australia (*O. H. Sargent*). U.S. Nat. Museum.

Related to the Tasmanian *H. disclusus*, Ckll., but easily separated by the red tegulæ. It is also a smaller species. The scopa on hind tibiæ is rather short and thin, but beautifully plumose.

XII.—*Notes from the Gatty Marine Laboratory, St. Andrews.*—No. XLII. By Prof. M'Intosh, M.D., LL.D., D.Sc., F.R.S., &c.

1. Preliminary Studies on *Filograna*: *a*, Historical; *b*, Faunistic; *c*, Structural; *d*, General.
2. On *Harmothoë watsoni*, M'I., an var. *H. marphysæ*, M'I.

1. *Preliminary Studies on* Filograna.

(*a*) Historical.

Filograna, the subject of the following remarks, has probably been known to marine zoologists from very early

times, though a definite name was not assigned to it. Amongst others, Seba * (1758), in alluding to various marine "mosses, corallines," and tubular corallines, *Congeries minutorum tubulorum*, which he figures in his 'Thesaurus,' specially refers to this form, which he found adherent to rocks and other structures, in one instance forming the basis to which *Thuiaria thuja* was attached (fig. 19 *a*). He figures correctly the spaces between the fascicles of tubes forming the mass. Though Plancus *De conchis minus notis* is quoted by some authors in this connection, nothing definite can be found in his work. Linnæus, Risso, Pallas, and others placed it under the genus *Serpula*, whilst a few included it under *Protula*. Oken termed it *Clymene filograna*; Ray, *Reticulatum trophaceum*; Boece, *Tubularia filograna*. The form is interesting in some other respects than zoologically, since it occasionally blocks the pipes leading from the sea to the Marine Laboratory tanks, as at Port Erin †.

Berkeley (1827) clearly described the form with the opercula, which he dredged at Weymouth. In the 'Zoological Journal, Volume of Supplementary Plates' (and not in vol. iii.) he gives a figure (pl. xviii. fig. 3) in which a somewhat pointed, hollow operculum is on each dorsal branchial filament. He shows seven pairs of thoracic bristles, and in the posterior (so-called abdominal) region is an indication of a twist, or it may be a bud.

Filograna implexa, as described by Sars ‡ (1846) in his first part of the 'Fauna Littorales Norvegiæ,' had six pairs of thoracic bristles in addition to the collar-bristles, two opercula on the dorsal branchiæ (right and left fans), and two eyes. He gave no minute description of the "vermidom" and figured only a few of its tubes.

Oscar Schmidt § (1848) alluded to *Filograna implexa*, and stated that he had found a new species at Faroë with buds at all stages. The same year he || described *Filograna schleideni* from the Faeroës, which he, as indicated, believed to be a new species, characterized by the absence of opercula and the arrangement of the eyes, which formed a row of four on each side of the middle line. He shows seven pairs of bristled feet in the anterior region, but does not differentiate the collar-bristles or figure them, unless he intends the first

* 'Catalogue of the Curiosities in the Cabinet of Albertus Seba.
† I have to thank Mr. Chadwick for this information.
‡ Fauna Litt. Norveg. i. p. 86, Tab. 10, figs. 12–19.
§ Frorieps Notizen, No. 143, p. 162, August.
|| Neue Beitr. Naturgesch. Würmer, Jena, p. 33, Taf. iii. fig. 7.

of the series, which follows the same backward slope as the others, to represent them, though this is unlikely. He describes and figures a bud, and compares it with budding in the Turbellarians and Naidæ. On the whole, there are no reliable grounds for separating this form from *F. implexa*.

Dalyell* (1853) gave a graphic account of the external features of the annelid and its mass of tubes, which, he correctly stated, was "penetrated by numerous deep cavities of indeterminable size and form." He also found the greyish annelids of unequal size, but he did not notice buds.

Huxley† in 1855 furnished a careful account of the southern type which he termed *Protula dysteri*, its distinguishing features being its "fissiparous multiplication" and its hermaphrodite condition. He described the branchiæ and their green blood-vessels; the alimentary canal with its crop, stomach, and intestine; the "vascular" system, which he did not consider equivalent to that of higher forms, the cœlomic fluid representing it; the nervous system, reproductive elements, setæ, and uncini; and concluded by a digest on fissiparous multiplication. He describes a ciliated canal running along the ventral surface of the intestine and apparently opening at the anus, but such probably was a misapprehension. He did not discriminate the differences in the structure and distribution of the bristles, yet the general account is worthy of the distinguished author, who, however, considered in 1865 that his form was probably identical with the northern type which had previously been described by Sars.

Keferstein‡ (1862) found the same form at St. Vaast with free-swimming young. His figures of the bristle and hooks are insufficient for identification, though they apply to the common form.

Claparède§ in 1863 procured *Protula dysteri* off the shores of France, and gave a detailed description of it. He likens the expanded branchial apparatus of the annelid to the lophophore of a Polyzoon. His examples had two eyes and occasionally other black specks. In the main his account agrees with that of Huxley, though he points out and figures the enlargements at the tips of the branchial filaments not mentioned by the English author. These enlargements,

* Powers Creat. ii. p. 250, pl. xxxiv. figs. 1–6.

† Edin. New Philos. Jour. vol. i. n. s. p. 113, pl. i. figs. 1–11.

‡ Zeitsch. f. w. Zool. Bd. xii. p. 128, pl. xi. figs. 23 & 24 (1862).

§ Beobach. Anat. u. Entwicklungs. Wirb. Thiere, p. 31, Taf. xv. figs. 16–22.

which he describes as leaf-like, are as conspicuous as in *S. ædificatrix*, but his representation of them (pl. xv. fig. 17) would convey an erroneous impression as to their structure and relationship to the filaments. He did not discriminate, however, the minute structure of the collar-bristles of the anterior region, and his description and figure of the hooks is also different from Nature, for he appears to have counted the serrations of each hook as a separate organ—at any rate, his figure diverges from Nature. The first segment of the posterior region (his abdomen) he describes as devoid of bristles. He did not notice the two anal papillæ. The male elements (ripe sperms) he placed in the thirteenth segment, and the female in the following seven to eleven segments. In his description of the buds he alludes to the early condition of the branchiæ, but with the exception of a figure of the early stage he adds little to what Huxley had previously recorded.

Claparède (1873) thought that Huxley exaggerated the views of De Quatrefages in regard to the blood-system of the Annelids. He considered a pseud-hæmal system quite different from that of the superior animals, and resembling the vascular form excretory system of the Rotifera, Cestodes, and Trematodes. He disagreed with this, for both morphologically and physiologically the blood-system is connected with assimilation.

De Quatrefages * describes the genus as having two false opercula, whilst his species *Filograna berkeleyi* and *F. implexa* do not appear to differ, for the coalescent uncini of the former and the angular teeth of the latter need not be seriously considered, since his figures of bristle and hook are not sufficiently accurate. His third form, *Filograna dysteri* is Huxley's species, and his fourth is the *F. schleideni* of Schmidt †, a variety of the common form. De Quatrefages overlooked the distinctive characters of the collar-bristles.

The genus *Salmacina* ‡ was established by Claparède § in 1868 for Serpulids having a thoracic membrane, regular branchiæ with a circular base, devoid of an operculum, the first thoracic segment furnished with tufts of distinctive and much larger bristles than those which follow, and dwelling in calcareous tubes. While it agrees with *Protula* in the absence of an operculum, it differs in the larger collar-

* Annales, ii. p. 485, pl. xv. figs. 9-12 (1865).

† Neue Beitrage Naturges. der Wurm. p. 33, pl. 3.

‡ Named after the hermaphrodite nymph *Salmacis*, a name already employed by L. Agassiz in the Echinids.

§ Annél. Chétop. Naples, p. 436.

bristles of the first thoracic segment. He was fully aware of its approach to the Serpulids and *Filograna*, yet the absence of an operculum separates it from both, though there can be no question of its close affinity with *Filograna*, the more so as *Salmacina* reproduces by posterior buds. He thought that *Protula dysteri*, which De Quatrefages united with *Filograna*, should probably be embraced in his genus, though the enlargements at the tips of the branchial filaments do not merit the name of opercula. He mentions, further, that it would be as reasonable to include the eyes at the tips of the branchiæ in *Branchiomma* as opercular as such swellings in *Protula dysteri*.

His first species was *S. incrustans* *, which he thought might be synonymous with *Serpula incrustans* (Linn.), Grube †, and *Serpula filograna* of Sacchi ‡. In his specific characters, however, no distinctive feature of moment is recognizable, for in length (2 to 2·5 mm.), colour, the number of the thoracic segments (8), the three kinds of dorsal bristles, the pectinate uncini, the flexuous calcareous tube incrusting *Zostera* and other marine organisms, and the hermaphrodite condition, there is nothing diagnostic. Thus Langerhans subsequently showed that even the number of the thoracic segments varied in this form from seven to nine. The presence of eyes again corresponds with the condition in *Filograna implexa* and *Salmacina dysteri*, as also does the structure of the first pair of thoracic bristles; though the bolder character of their serrations above the "knee" indicates variation, it may be from environment, whilst the absence of serrations in the tapering blade beyond the hiatus in Claparède's description and figure is due to the artist, for they are present in specimens from Naples. The description and figures of the two other forms of bristles agree with the conditions in *Filograna*; and the same may be said of the abdominal bristles and the structure of the hooks. Claparède found in one a double tip to the tail with two cirri, perhaps the result of injury.

He regarded the anterior glands (nephridia) as the secretory organs for the tubes. Further, he describes the hermaphrodite animal as provided with orange ova in the anterior region of the abdomen, and zoosperms in the posterior, even to the extremity, and the sperms had an elongated head. Such an arrangement therefore differs from that usually observed.

* *Op. cit.* p. 436.
† Echeniod Actin. u. Würmer, p. 62.
‡ Catal. Conch. reg. Neapol. p. 19, 1836 (*fide* Claparède).

In the 'Supplement to the Annelids of Naples' (1870) Claparède * repeats the generic characters he had previously given, only adding that spatulate or pectinate bristles are absent from the posterior region. He also differentiates *Psygmobranchus* more definitely from *Salmacina* by the entire absence of buds in the former, and by the hermaphrodite condition in *Salmacina*, which is to all intents and purposes, he says, a *Filograna* deprived of its operculum.

In this publication he describes a new species, *A. œdificatrix* †, characterized by the whitish granular tubercles along the exterior of the filaments, the absence of eyes, and the presence of nine thoracic segments, the other features being common to it and the other species. He states that this form is very near *S. incrustans*, which is found adhering throughout its length to the surface of Fuci and other marine plants, to the surface of shells, and other bodies, whereas *S. œdificatrix* is a deep-water form which constructs masses, by the branching and anastomosing of its tubes, identical in structure with those of *Salmacina dysteri* (from which the Neapolitan form is readily discriminated by the absence of enlargements at the extremity of the branchiæ), and so with *Filograna*. He thinks the structure of *S. œdificatrix* leaves little doubt as to its reproducing by posterior buds.

In his figure of the collar-bristles he is more accurate than Langerhans, the number of serrations on the flattened basal region being seven, and the hiatus is more in accordance with Nature ; yet the bristle, as a whole, does not differ in any way from that of *Filograna*. The other segments carry bristles which do not differ from those of *S. incrustans*, and, it may be added, from those of *Filograna*. He holds that the hooks differ from those of *S. incrustans*, but it cannot be said that his figure (pl. 13. fig. 1, E) represents a full lateral view of the organ, but rather a partial lateral view, thus giving it greater length proportionally than it really has. These small organs are not readily mounted so as to exhibit a complete lateral view, and thus the able Swiss author was misled. They seem to agree with all the other forms examined.

Amongst other features, the author states that the achetous region between the thorax and the first abdominal bristles is equal to four or five segments, and that the abdominal bristles are capillary and winged, with a "knee" at the

* P. 154.
† P. 157, pl. xiii. fig. 1.

tip. At the base of the branchial pinnæ are rows of granular cushions, but all he says about the extremity of the filaments is that they are bare, and in his drawing they are somewhat delicately tapered.

Giard* (1875 and 1876) made two notes on the development of *Salmacina dysteri*, Huxley, with figures, from the early ovum to the post-larval stage, having three pairs of bristles. The description and figures of this able and industrious author are excellent.

Langerhans† (1880) describes *Salmacina incrustans* from Madeira as occurring in tubes on stones between tide-marks and on fish-baskets. The terminal process of the branchiæ has a coloured cushion composed of epithelial cells and at the tips of the pinnæ "einige solche Zellen." In the Mediterranean form these cells were absent. A pair of eyes; five to seven setigerous segments anteriorly, the first bearing the characteristic bristles, one of which he figures with five serrations on the wide basal process below the hiatus (Taf. v. fig. 40 *b*), and the other with a serrated edge devoid of a hiatus, but Neapolitan examples of the species show smaller and more numerous serrations on the basal web of the tip, viz., about double the number indicated by Langerhans, and the hiatus is less pronounced. This remark is made on the supposition that the form from Madeira is the same as that at Naples. The ventral uncini have only five teeth above the main fang, whereas in *S. ædificatrix* there are six; yet in the figure of the face of the hook in each case there are nine transverse rows. The anterior bristle with the curved (sickle-like) tip and serrations is also present, though the figure is indifferent. Bristles with smooth wings occur in this region, but he does not indicate any differentiation at the tip of the tail, though he describes those of *S. ædificatrix* as having serrated wings. In the Neapolitan examples the serrations of the tip were less prominent.

Carus (1885) distinguishes *Salmacina* thus: Thoracic membrane; branchiæ equal, base circular, destitute of an operculum. First thoracic segment with a tuft of bristles larger than the succeeding and of a distinct form, semicrenulate. From the third segment, besides winged setæ, are others semicrenulate. Spatulate and pectinate bristles absent from the abdomen—only simple falciform bristles.

He makes Claparède's *S. incrustans* synonymous with ? *Serpula filograna*, Sacchi, and so with ? *Serpula intricata*,

* Comptes Rend. Acad. Sc. 17 January, 1875, and 24 January, 1876 Also 'Œuvres Diverses,' p. 316.

† Zeitsch. f. wiss. Zool. Bd. xxxiv. p. 122.

Grube, though the latter conclusion is unlikely. The body is 2–2·5 mm. long, of an orange colour; thoracic segments 8; dorsal bristles of two kinds; uncini pectiniform; tube sinuous and calcareous, incrusting *Zostera* and other marine structures. There is no diagnostic feature in this description.

S. ædificatrix. Body dull orange, 2–2·5 mm. long, segments 45–50; branchiæ 4, white, with pale granular tubercles externally; no eyes; thoracic segments 9; collar-bristles geniculate, cuspidate at the base of the wings; rest of the segments have subulate bristles with wings, others pectinate; falciform; hooks small, multidentate; tube capillary, densely glomerate, and intricate.

Cunningham and Ramage * (1887), while giving no details, have a figure of an adult example and a larva of *Filograna implexa*. The adult has eight pairs of anterior bristles, a pair of eyes, and opercula on the branchiæ. The larva has three pairs of bristles, two large eyes, and a prominent prototroch.

Ehlers † (1887) examined a form from the Tortugas which he named *Filigrana huxleyi*; having the general structure described by previous authors, with ova in the posterior segments (12–20), and in the case of a nurse-stock, from the seventh posterior segment of which a bud of six thoracic and seven abdominal segments arose, there were no reproductive elements. Each branchial filament, as in *Filograna dysteri*, ends in a pear-shaped, cellular, flattened swelling with palpocils. He considers such an organ may be connected with food-supply, since he found a *Nauplius* amongst the pinnæ. The stomachs, however, of most examined in Britain had only such objects as currents supplied, and in those from deep water Coccoliths were common, and so with many foreign forms. Ehlers states that Huxley describes certain warts on the branchiæ of his species, but they were not present in the American form. The homologies of the terminal enlargements with opercula or eyes (*e. g.* in *Branchiomma*), as Langerhans considered in *Salmacina incrustans*, are referred to. Ehlers gives a figure of the characteristic collar-bristles which differs from anything hitherto seen in the group, in so far as it has only six large serrations to the basal division of the wing, no hiatus, and a long, smooth, tapering tip, Further, no bristle

* Trans. Roy. Soc. Edin. vol. xxxiii. p. 673, pl. xlv. fig. 35.

† "Report on the Annelids of the 'Blake,'" p. 314, Taf. 56, figs. 4–9.

with a reaping-hook curve is present in the succeeding segments, only those with a "knee" and an ordinary winged tip. The hook agrees with that found in the common *Filograna*, though the artist has not represented the streaks at right angles to the serrations. The earliest bud has only segments similar to the abdominal of the parent.

He considers his species near Huxley's *Protula dysteri*, though it has no eyes; both have the terminal organ of the branchial filaments. So far as can be seen, there is nothing in Ehlers's description to distinguish his species from *Filograna implexa*.

Lo Bianco * (1893) mentions the following hermaphrodite forms: *Amphiglena*, *Salmacina*, *Spirorbis*, *Pileolaria*, &c., the ova being deposited in the interior of the tube or placed in the operculum; the young by-and-by forming colonies by fission. Fissiparous reproduction occurs in *Salmacina* and *Telepsarus*.

In 1894 De St. Joseph † made a contribution to the history of this species (*Salmacina dysteri* variety), which he dredged frequently on shells, on *Rytiphlœa pinastroides*, and collected on rocks and stones at Rochardieu. He gives the size as 6 mm., and shows how in many features it resembles *Filograna implexa*, only it has no operculum. He further states that each branchial filament is terminated by a peculiar enlargement formed by a double row of cells with palpocils, the latter also occurring on the pinnæ. The segments of the anterior region (thorax) range from seven to nine, and have bristles and hooks resembling those of *Filograna implexa*. The naked region behind the anterior has ten or twelve segments, whilst the posterior region (abdomen) has from 40–50 segments, the middle being narrowed, and the anterior and posterior parts dilated, the tip again narrowing to the two terminal papillæ. The bristles agree with those of *F. implexa*. The alimentary canal, the blood-sinuses around the gut, and the excretory organs anteriorly debouching by a common aperture are all in accordance with the parts in *F. implexa*. He found ripe eggs and ciliated embryos in the cœlomic cavity, proving that impregnation is internal, the earlier atrochous forms of similar size to the eggs, and with two minute eyes in front; besides others more advanced, with a ciliated collar behind the eyes, three setigerous segments, and an anal. No hooks are present. This stage he thought anterior to that described by Giard in

* "Gli annellidi tubicoli trovati nel Golfo di Napoli," *op. cit.*

† Ann. Sc. Nat. 8e sér. t. xvii. p. 340, pl. xiii. figs. 375–380.

the tube of the parent. Moreover, *S. dysteri* reproduces by buds, as in *F. implexa,* the nurse-stock of seven or eight anterior and fifteen to seventeen posterior segments, without sexual elements, giving rise to a bud at the eighth or ninth posterior segment as in *Filograna implexa.* He concludes by stating that *S. dysteri* is met with in different conditions :—

1. As a hermaphrodite form without buds, measuring 6 mm., with the anterior segments of the abdomen enclosing the male and female sexual elements, the following segments constricted, and the terminal enlarged.

2. As a short annelid of twenty posterior segments, without the filiform portion of the abdomen and which prepares for budding, or perhaps has already budded and regenerated, the detached segments.

3. As a form of the same size as the preceding with a bud at the eighth or ninth posterior segment.

4. As a shorter form from which a bud has been detached, which possesses only nine or ten posterior segments and is devoid of eyes.

In regard to the resemblances between *Filograna implexa* and the present species, they are identical except for the absence of the opercula in *Salmacina.* He mentions the case of the *Protula* described by Fritz Müller, which acquired an operculum on one of its pinnate branchiæ ; then the barbules disappeared, and the filament became the stalk of the operculum. In *Salmacina dysteri* at complete maturity he found each of its branchiæ terminated by a mass which offered no indication of an operculum ; and, since *Filograna implexa* at complete maturity retains its two opercula, he is of opinion that the two species are stable and distinct. Yet this very statement shows that between *S. dysteri* and *S. œdificatrix* there is a facile step on this head alone.

In referring to the proposal of Ehlers to suppress the genus *Salmacina,* Claparède, since its bristles resemble those of *Filograna,* De St. Joseph would conserve the genus *Filograna* as revised by Ehlers, but would divide it into two subgenera—viz., *Filograna* with an operculum and *Salmacina* without one.

De St. Joseph found on the tubes *Folliculina ampulla* and *F. atropurpurea,* anastomosing amongst them and the minute sponges, and Corynids and ova were also present. He observes that the dorsal hooks in the posterior region resemble the thoracic ventral hooks, but their rows are short and their number few.

Malaquin * gives also an account of the sexual and asexual phases of *Salmacina dysteri* :—

I. Phase of a young protandrous form. The male genital segments are incorporated with the thorax, and are sterile.

II. Phase is that of asexual reproduction, or schizogenesis. In this the animals present incomplete male sexuality, manifested by the production of a few spermatozoa which attain maturity.

III. Phase—hermaphroditism. Gonads (male and female) are situated in distinct segments—the male in the three (two to four) anterior abdominal segments, the female in the eight to ten segments which follow. The *circulation* in *Salmacina* and *Filograna* resembles that of the Serpulids in the particular reticulation of vessels distinct from the cœlom. There are branchial and ventral vessels. Around the intestine is a vascular sinus, as in Serpulids and Sabellarians. In *Salmacina* and *Filograna* this sinus lies between the endothelium splanchnoplanique of the cœlom and the intestinal epithelium. This part of the hæmocele represents exactly the primitive blastocœle.

The same author † (1911) gives an elaborate disquisition on the phases of *Salmacina*, grouping them as follows :— I. The sexual forms, including the young protandrous forms, with three to five segments in the thorax, two intermediate, and six abdominal segments. II. The unisexual, rarely female, less rarely male. The female is $2\frac{1}{2}$ mm. long, with three thoracic segments, an intermediate asetigerous segment, and six to eighteen abdominal distended with ovocytes. Probably this becomes hermaphrodite. The male is $1\frac{3}{4}$–$2\frac{1}{2}$ mm., with seven thoracic segments, sixteen ripe abdominal segments, and three or four terminal.

The hermaphrodites have eight branchiæ, eight thoracic segments, then two or three achetous segments ; immediately behind are two or three with male gonads, and the succeeding ten have female gonads with red ova. They reach 6–7 mm., and may have fifty abdominal segments. In some hermaphrodites male elements predominate, the female segments being reduced. In others a hermaphrodite segment occurs at the limit of the male region, the male elements being on one side, the female on the other. He has also seen a hermaphrodite gonad. .

The metamere, as a rule, is unisexual, but, as mentioned, between the male and female regions a hermaphrodite one

* Assoc. Française Adv. Sc. Lille, 1909, p. 135.
† Zool. Anzeiger, Bd. xxxvii. p. 201.

may occur. A large well-developed ovum may appear in the cœlom and a male gonad in the segment.

In *schizogony*, in its asexual phase, it is exceptional to find seven segments in the thorax. At the tenth abdominal segment cephalo-branchial proliferations occur with two new segments of the thorax, instead of the three or four of the oozoite. No sexual elements appear. In *schizogony* accompanied by sexuality male elements are found in the abdominal segments (9–10), such probably being a further stage of the protandrous young. In the hermaphrodite forms the elements are reduced in quantity—for instance, in a schizonozoite of twenty segments.

He makes the noteworthy remark that schizogonous individuals by their size and the number of their segments are little advanced in age compared with the hermaphrodite forms. Another fact is that when sexuality is present it is reduced male, female, or hermaphrodite. These are stages in the march to complete hermaphroditism.

Malaquin concludes that *Salmacina dysteri*, Huxley, exhibits all the forms of sexuality possible. It, indeed, shows a kind of indifferentiation in sexuality, marked by the absence of secondary sexual characters in the individual. The sole character which distinguishes the phases from each other is the position of the genital segments and their state of advancement. Schizogony occupies the middle period of the existence of the annelid. It is intercalated between the two sexual periods—protandrous or rarely female, or hermaphrodite. The sexual period ultimately marks the end of the evolutionary cycle in *S. dysteri*. The exclusive sexual form is hermaphroditism. In a certain number of these the male elements predominate. It thus reappears in the life-cycle after its presence in the young oozoite.

Miss Pixell* (now Mrs. Goodrich) describes *Salmacina dysteri* from Gough Island, in the Antarctic Sea, as occurring in fairly large masses. No buds were present. She also finds the same species in various parts of the Indian Ocean†.

Fauvel‡ (1914) describes *Filograna implexa* from the Gulf of Gascoigne, Monaco, and other sites, the agglomerated tubes forming considerable masses analogous to those of *Salmacina dysteri*, from which, he observes, the animal is easily distinguished by its two opercula. The same author alludes to *Salmacina incrustans*, the very fine tubes of which

* Trans. Linn. Soc. vol. xvi. p. 87 (1913).

† Trans. Roy. Soc. Edin. vol. xlix. p. 350 (1913).

‡ Campag. Sc. Monaco, Fasc. xlvi. p. 327. I am much indebted to Prof. Fauvel for specimens and memoirs.

are more or less agglomerated on stones or shells. Certain specimens have the branchiæ coloured red at the extremities —an accidental condition. The collar-bristles have the web at the base of the tip with large teeth (two or three prominent) and with a few capillary bristles. There is no operculum. The uncini have numerous teeth. He distinguishes *S. dysteri*, Huxley, from the foregoing by the numerous fine teeth on the basal web of the collar-bristles. All the specimens had sausage-like cellular masses at the tips of the branchial filaments. He was of opinion that the *S. ædificatrix*, Claparède, was the same species. He never encountered a true representative of this species, which, he says, is distinguished from *S. dysteri* by the absence of the enlargements at the tips of the branchial filaments, and adds, strange to say, that the tubes are often intertwined with those of *Filograna implexa*.

J. H. Orton * (1914) states that the common species of "*Filograna* carries ripe eggs and trochospheres at an age probably less than 4 months, having grown through the summer. About the same time another experiment yielded specimens with fully-developed eggs at an age not greater than 10 weeks and 4 days. Later in the year full-sized specimens with buds had an age not greater than 4 weeks and 2 days. There can be little doubt, therefore, that in this species there is an alternation of generations, the summer forms producing eggs and sperm, and the autumn and winter ones producing buds."

(*b*) Faunistic.

In order to give a satisfactory view of the remarkable variations of *Filograna*, it is necessary in the first instance to glance at the condition of the specimens from the several grounds, which range from Shetland to the Channel Islands in Britain, and elsewhere from diverse distant localities stretching almost from pole to pole †.

In those from Plymouth no operculum has been seen up to date. In an example with a bud the branchiæ had short pinnæ, but the tips had sausage-like enlargements; the anterior region had seven lateral bristle-tufts besides the collar-tuft, two segments succeeded the anterior region without bristles; thirteen bristled segments followed; then the bud, the first two segments of which had no bristles, and twenty-three with bristles succeeded, two papillæ occurring posteriorly. Its branchiæ were simple filaments. In

* Jour. M. B. A. vol. x. p. 316.

† Those from the area of the Clyde was sent by Mr. L. Renouf of the Museum and Laboratory at Rothesay.

older examples without a bud the anterior region had seven pairs of bristles besides the collar pair, a considerable smooth region, and fifteen segments and the pygidium posteriorly. The branchiæ were well developed, with sausage-shaped enlargements of the tips of the filaments, and the pinnæ were much longer than in the former. The apertures of some of the tubes show a slight expansion like the muzzles of old-fashioned shot-guns for sparrows, whilst others have cylindrical though rounded margins. In the first series of bristles, which in lateral view have the tip at an angle to the shaft, the basal part of the wing has numerous (fully a dozen) serrations sloping from the base to the distal end in lateral view, and then a hiatus, followed by a minutely serrated tapering blade. When viewed from behind, the shaft diminishes little to the end of the basal section of the wing, and the axis can be followed, as distinct from the wing, from the base to the tip, and then gradually tapers distally. Certain views point to the double nature of the basal expansion, serrations being seen on both sides. It may be that something similar exists in the distal wing. What have been mentioned elsewhere as simple bristles in this tuft are apparently only developing forms of the special type.

Channel Islands (off Guernsey and between tide-marks, Herm).

Most form fixed tubes on shells and stones—two opercula, as a rule, on each; these may be large and thin, or less expanded as circular discs. No enlargement of the tips of the other filaments. This form is common under stones (to which it is attached) between tide-marks in the Channel Islands. Ova occur in the posterior region of body. In the structure of the collar-bristles no distinction can be drawn between these and the Plymouth forms. The shaft, basal wings, and tip are the same. The hiatus and the mode of origin of the distal part of the wing agree, as also do its minute serrations.

St. Andrews.

Branchiæ without an operculum in two bearing buds; tips of branchiæ cylindrical in some, in others slightly clavate (in the spirit-preparations). The condition of the branchiæ depends on age; in young examples the filaments and pinnæ are short, but they vary, some of the same size of body having larger and better-developed branchiæ. The young have a short body. The collar-bristles show several with curved tapering tips, which do not have the gap

separating the widened and more boldly serrated base from the more minutely serrated terminal region. The structure of those with the gap, however, does not differ from that of the Plymouth form. The buds presented a similar condition, and the serrations of the basal region of the tip were bolder than the distal. In some of the unaltered tips slight hollows at the site of the gap indicated a change. Further, in addition to the foregoing, a series of simple tapering bristles without evident wing were present.

Off the Hebrides.

Two well-developed opercula of a flattened finger-nail shape. Series of rounded eye-specks. No enlargement of the terminal processes of the branchial filaments; long body; eight pairs of anterior bristles. Collar-bristles apparently agreed with the St. Andrews form.

S.E. of the Isle of May. August. 32 fathoms.

Two opercula, circular and rather small. No enlargement of the tips of the branchial filaments, and the pinnæ comparatively short. Ova in some with comparatively short bodies. Collar-bristles apparently similar to those from St. Andrews.

Shetland.

Two opercula (small and round) in some, others have none. The examples are small. Collar-bristles similar to those from St. Andrews.

Moray Frith (dredged).

Well-formed thin operecula. In another none. No enlargement of the tips of the branchial filaments in either. The collar-bristles in these forms agree with those from St. Andrews.

Aberdeen Bay. August.

Well-marked opercula in all. No enlargement at the tips of the branchial filaments. Collar-bristles indistinct, but apparently agreeing with those from St. Andrews.

H.M.S. 'Triton' and 'Knight Errant.' 530 and 87 fms.

An operculum is present in these as a rule, but it is a very thin circular plate—so thin as to be distinguished with difficulty in certain examples. No eggs, sperms, buds, or larvæ were seen in these specimens in August. Numerous coccoliths occurred in their stomachs. The specimens from both ships had exactly the same structure in the collar-bristles as at St. Andrews.

North Sea *.

Station 18 *a*. 455 m. No. 29. 18.6.1906. Procured with the small trawl.

The shelly tubes of this form exactly resembled those of the other varieties. The annelids, whose bodies were of moderate length, are characterized by the free development of the branchiæ, which possess large filaments, and long and rather slender pinnæ with scarcely a trace of enlargement at the tips. The filaments do not appear to show any glandular thickenings such as occur in *Salmacina ædificatrix*. At the extremities the filament, which is comparatively broad at the last pinna, gradually tapers to a blunt point.

In one example with eight pairs of anterior bristles the two dorsal filaments were modified in an interesting manner, since one presented a somewhat thick terminal process, the tip of which was abruptly bevelled mainly on one side, the tapering tip being rather blunt, its cellular structure otherwise remaining the same as its neighbours ; whilst the other had advanced a stage further, the clavate tip being unequally bevelled and hollowed so as to form a rudimentary operculum. This example carried ova well forward in the posterior region, but as it was imperfect, too much reliance need not be given to this feature. The region frequented by this colony seemed to be highly favourable, for in another example the tips of the branchial filaments were irregularly enlarged.

Station 18 *a*. 14.3.1907. Trawl.

Eyes present.

The type consisted of comparatively short bodies, with seven pairs of anterior bristles, and about twenty-five segments posteriorly, comparatively long branchial fans—fully half the length of the body, and with opercula. The form of the opercula, however, varied considerably from the thin, translucent, and more or less circular or hoof-shaped cup to a long vase with a tapering process on the lip, a bluntly clavate termination, or a cone at the end of the filament. The short bodies are terminated by the two anal papillæ. So far as could be observed, no reproductive elements were present. Food was abundant in the stomach, and the intestine had the elliptical fœcal masses.

The structure of the collar-bristles is identical with that in the St. Andrews examples.

Station 10. 27.5.1907.

These were characterized by small, thin, wineglass-shaped

* I am indebted to Prof. D'Arcy Thompson for the opportunity of examining these.

opercula, seven pairs of anterior bristles, short pinnæ to the branchiæ, the filaments of which had rather short, stumpy, terminal processes, and by the great number of small ova, which in some stretched far forward. The number of the small ova far exceeded that seen in any other form, and point to their probable extrusion before fertilization, or, at any rate, immediately after. Sperms were not clearly demonstrated in front, but they may have been present, though in one the ova passed forward to the anterior region. This form also shows the isolated and elliptical fœcal balls in the posterior part of the gut. In structure the collar bristles correspond with those from St. Andrews.

Station 16 *a*. 195 m. No. 202. 9.6.1908.

Some had no opercula, others had two of the ordinary funnel-shape. In several without opercula the tips of the filaments were rather short and little tapered. In another the tips of the two dorsal filaments were flattened and wider than the rest. The number of the anterior bristles was seven pairs.

One presented the same circular or rounded granular masses on each side of the gut in the caudal region. Others showed distinct ova (small). The former is probably the early condition of the latter. In structure the collar-bristles agree with those from St. Andrews.

Station 16 *a*. 324 m. 13.6.1908.

The examples have slightly larger tubes, more laxly put together, and often showing a lip where the annelid protrudes—that is, the edge of the tube is expanded a little and turned over. The annelids have no opercula, and rather long tapering tips to the branchiæ, which also have long pinnæ. The collar-bristles have the same structure as those from St. Andrews.

Station 18 *a*. 324 m. 13.6.1908.

These have seven or eight pairs of anterior bristles, long branchiæ, with transparent opercula, and long pinnæ on the filaments, which in those having opercula showed no enlargement. In one about twenty of the terminal segments contained rounded granular bodies like early ova. In young forms seven pairs of anterior bristle-bundles occurred, and the branchiæ had short pinnæ and thick filaments. The posterior region in these had between twenty and thirty segments. The tips of the non-opercular filaments were rather long and tapered. In those with the granular masses posteriorly, no large ova could be seen. The aperture of

the tube is in some expanded a little and turned over. The structure of the collar-bristles is precisely the same as in the St. Andrews examples.

Station 18 *a*. 455 m. 18.6.1906.

The tips of the branchial filaments are enlarged as flattened lobate processes in every instance, and in several the expansion passed down the filament for some distance. The pinnæ on these filaments were all rather long and slender, and in marked contrast, for instance, to those from Plymouth, in which the short thick pinnæ are diagnostic, the whole branchial apparatus being less developed. The great length and the number of the pinnæ in the form from the North Sea give the branchiæ a densely capillary aspect. As a rule, the terminal pinnæ are shorter and thicker, partly, in all probability, from more active growth. Besides the examples just mentioned others showed similar enlargements at the tips of the filaments and no opercula; whilst in a third series a minute, flattened, or slightly saucer-shaped operculum appeared on each dorsal filament. Such could have been of no service as a protection. The structure of the collar-bristles of these specimens corresponds exactly with that of the St. Andrews form.

Station —. Off Moowick Head, 99 m. No. 165. Captured in trawl. 12.8.1908.

All these presented the rounded granular masses (early ova) on each side in the caudal region, and no ova in front. Opercula were present, and seven or eight pairs of anterior bristles. In structure the collar-bristles agree with St. Andrews examples.

Station —. 15.8.1908.

Those examined had two opercula and no enlargements at the tips of the branchial filaments. The anterior bristles were seven or eight, the young having fewer. The collar-bristles agree with those from St. Andrews.

'Porcupine,' 1870. 45 fms. off Cape Sagres.

In these examples the branchiæ are of moderate length (about that of the specimens from Plymouth) and furnished with two well-formed opercula. The pinnæ are somewhat more slender than those from Plymouth. Moreover, most or all of the opercula had a little process on the edge of the comparatively large organ. The rest of the filaments ended in a tapering tip. There were eight pairs of anterior bristles. The collar-bristles are minute and transparent, but the basal region of the wing is differentiated and serrated as

usual, then a gap occurs, after which the distal finely serrated wing tapers to a slender point. These bristles are more minute than any hitherto examined.

Norway.

These have large branchiæ, no opercula, and the tips of the filaments are comparatively short, not expanded, whilst the pinnæ are numerous. No sperms were seen, but ova occurred in the anterior region of the abdomen. There were seven pairs of thoracic bristles. Here then was a variation from the form described by Sars which had two opercula. The structure of the collar-bristles entirely agrees with that of the St. Andrews examples.

Naples. (*Salmacina ædificatrix*, auct.)

The comparatively large size of these examples and the great development of the branchiæ, their glandular swellings along the filaments, and the large size of the sausage-like tips, as well as the common occurrence of nine pairs of anterior bristle-bundles make them conspicuous. The pinnæ also take on the tendency to increase at the tips, especially the distal pinnæ, yet these pinnæ are not so long as in certain forms from the North Sea, also devoid of an operculum. The development of the axis or filament of each branchia is in contrast with the smaller parts in the northern seas, the glands of the filaments being smaller. The points or main fangs of the minute hooks appear to be directed forward—both in the anterior and the posterior regions. So far as can be seen, the sperms occur behind the bare segments of the anterior part of the posterior region, and in one with embryos they seem to pass backward, some being present at each side of the tail. In this example (with embryos and ova) the tips of the branchiæ showed rather less than the usual enlargements. The granular masses at the sides of the tail, however, may be sperms. Yet they resemble the granules in front. In those with advanced embryos most of the sperms appear to be shed.

The collar-bristles agree in structure with those from Plymouth and the north, having a basal division of the wing with numerous serrations, a gap, and a tapering distal region with a minutely serrated edge. The bristle has the same curvature at the end of the shaft. Ten points at least appear in a favourable view of the basal web of the collar-bristles and the others agree with those of the northern types.

Dongonab, Red Sea. 2.12.1915.

The vermidom is of the open pattern, so that aeration

goes on readily, yet it is stated they grow in quiet nooks at Dongonab. The long branchiæ are richly pigmented, and each animal is provided with a pair of eye-specks composed of a group or crescent of four or five points. The web at the base of the tip of the collar-bristles has eight or nine teeth. The tips of some of the branchiæ in a few are enlarged. In others this is not seen. One had more slender pinnæ than usual, and in this the tips of two of the filaments presented enlargements of the sausage-shape with lateral glands as in *S. œdificatrix*. All have six pairs of anterior bristles, viz. first and five following. No opercula are present. One or two buds (early) were attached to the nurse-stock; and many young forms occurred. Buds thus develop in the quiescent condition of the reproductive elements, which were not visible.

Dongonab, Red Sea. 2.2.1916.

Since December (1915) the reproductive elements have been developed, the large ova occurring in masses in the non-bristled region behind the "thorax," leaving the posterior and caudal regions free. In some the spaces between the septa were filled with a uniformly granular mass. In a small form, which seemed to be male, the elements filled the posterior and caudal regions to the tip, whilst anteriorly the masses reached the thoracic border. No buds were observed in this series. The tips of the branchial filaments were slightly enlarged in some ovigerous forms, the outline being ovoid rather than sausage-shaped as in *S. œdificatrix*, and in this respect they agreed with those procured in December, and in which the reproductive organs were not developed; indeed, some of the latter had large processes, so that this does not appear to be connected with the development of the gonads. The young as well as the adults presented the same slight enlargements of the terminal processes of the branchial filaments.

Dongonab, Red Sea. 5.1916.

Since February the reproductive elements in the body have disappeared, and more frequent instances of budding present themselves, the buds arising in a similar manner from the posterior end in front of the pygidium which forms the anal extremity of the bud. The tentacles develop early, and enable the eye to detect the bud even when very small. At a little later stage the outline anteriorly is marked by a separate and symmetrically shaped area—apparently the rudiment of the "thorax."

Dongonab, Red Sea. 9.1916.

Many of the tubes were empty, and the forms were young.

In the Red Sea *Filograna* produces ova in the coldest month of the year. In the same region Dr. Crossland * found that *Meleagrina vulgaris* sheds ova in the winter, whilst *M. margaritifera* breeds only in the summer. The same careful observer remarks that he has not yet seen *Filograna* amongst coral, but it is common on buoys, on the bottoms of boats which have been standing in the harbour, on piles in sheltered water, and in sponges. All its habitats in shallow water are sheltered, and the fragility of the calcareous tubes probably render this necessary.

Madras Harbour, India †.

Tubes of the same form were dredged by the late Dr. John Anderson east of Verribles, India, in 13 fathoms.

The branchiæ of those from Madras Harbour show slight enlargements at the tips of the filaments. Though the preparations were not very favourable, yet in an example one of the tips exceeded the others in size, but had the same structure. As a rule, the tips are probe-pointed, though in some the terminal cushions are larger and more boldly glandular. From seven to eight pairs of bristles occur in the anterior region. So far as could be observed, the structure of the collar-bristles is typical.

Sydney Harbour, Australia. 4.1916 ‡.

The specimens are characterized by the blackish colour § of the branchiæ—especially their distal ends, which thus boldly contrast with the white tubes, and the anterior region of the body in some is also of a dark hue. The branchiæ appeared to be comparatively thick and stumpy, the pinnæ in some and the terminal process of the filament devoid of enlargement, though it was stout. All had two eyes. The number of the bristle-bundles of the anterior region was usually nine, young forms had eight. There were no opercula. The collar-bristles agree with the type found at St. Andrews.

* To whom I am greatly indebted for these and many other specimens.
† For the examination of these I have to thank Dr. Annandale.
‡ Kindly forwarded by Prof. Haswell.
§ Whether osmic acid had been used for killing is as yet unknown.

Some had the posterior region of the body distended with large ova. None had buds, but a band or two of large free ova in mucus occurred, as in the specimens at St. Andrews and as is also found in *Spirorbis*. Some of the tubes of mucus contained larvæ with three pairs of bristles, a powerful prototroch, two large eyes, and a segmented body.

A commensal Crustacean was found in the calcareous tube.

PLYMOUTH.

Operculum (none).	Branchiæ (tips).	No. of anterior bristles.	Serrations of basal web of collar-bristle.	Gonads*.
....	Slight enlargement.	7	About 12.	Ripe sperms.
....	No distinct enlargement	6	Fewer than 12.	....
Larger example .. *March.*	Enlargement greater.	8	About 10?	....
Young specimen .	Enlarged tips.	8	„ or more	....
Very young	....	8	„	....
Young ..... *June.*	Enlarged tips.	8	„	....
With bud	„	7	„	....
Fairly adult	„	8	„	....
„	„	8	„	Ova.
„	„	8	„	Ova.
„ (short post. region) ..	„	9	„	....
Fairly large	„	7	„	Ova.
„ with bud.	„	8	„	....
„ „	Slight.	8	....	....

GUERNSEY.—JULY.

Branchiæ. Opercula.	Branchiæ. Sausage-tips.	Anterior bristle-tufts.	Collar-bristles. Basal comb.	Remarks.
....	1	7 pairs.	About 1 dozen serrations.	....
2 opercula.	....	8 „	About 1 dozen.	....
2 „	0	7 „	„	Branchiæ pigmented brown (or red?).
1 only visible.	....	6	„	....
....	2 or more.	8? .	1 apparently with fewer teeth.	On shells.
2 opercula.	....	8	....	....
2 „	....	7	....	On shells.

* The male elements were present in the majority with ova.

St. Andrews.

Branchiæ. Opercula.	Sausage-tips.	Anterior bristle-tufts.	Collar-bristles.	Remarks.
....	All with sausage-tip (long).	7	Fully 1 dozen fine serrations.	Large example.
....	....	8	....	....
Bud.	Slightly enlarged tip.	7 (developing).	No distinct notch.	Apparently fine teeth.
2.	....	7	....	June.
....	....	8	....	„
....	....	8	....	„
....	Slightly enlarged tips in two specimens.	....	....	....
2.	....	....	....	Bud, September.
1 developing.	....	7	....	„ „
1 developing.	....	7	....	Nearly adult, „
2 developing.	....	7	....	September.

Off Hebrides.—July.

Branchiæ. Opercula.	Sausage-tips.	Anterior bristle-tufts.	Collar-bristles. Basal web serrated.	Remarks.
Large example, 2.	....	8	....	Pigment on branchiæ, two eyes.

Off Isle of May.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.
2	With pigmented tips.	7	Web with small teeth.

Off Shetland.

Opercula.	Branchiæ.	Anterior bristles.	Remarks.
Young, 2.	No enlargement of tips.	7	Ova.
Adult 2 or none.	....	....	....

Moray Frith (dredged).

Branchiæ. Opercula.	Sausage-tips.	Anterior bristle-tufts.	Collar-bristles.	Remarks.
2	None.	7	Typical.	....
2	None.	8	„	Ova.
1	Very slight enlargement.	8	„	....

Aberdeen Bay.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
2	No enlargement of the tips.	7	Small teeth (12).	Ova.

Port Erin.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
None.	Tips of filaments black.	8–9	Typical.	....

'Knight Errant.'—August.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
2	....	7	Typical.	Coccoliths in stomach.

North Sea.

Opercula.	Eyes.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
Stat. 18 *a*. 18.6.06.	2 or none.	....	Largely developed, no enlargement at tip.	8	Typical.	Ova.
14.3.07.	2.	Present.	No enlargement of tip.	7	„	....
Station 10.	2.	....	„ „	7	„	Ova numerous and small.
Stat. 16 *a*.	2 or none.	....	„ „	7	„	Ova.
13.6.08.	None.	....	„ „	7	„	....
Stat. 18 *a*. 13.6.08.	2.	....	„ „	7–8	„	Ova.
Stat. 18 *a*. 18.6.06.	2 or none.	....	Those without opercula had enlarged tips to filaments, which were long and slender.	7	„	Sperms.
No. 165. 12.8.02.	2.	....	No enlargements.	7–8	„	Early ova?
15.8.08.	2.	....	„ „	7–8	„	Sperms.

'Porcupine,' 1870.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
2 with a minute process.	Slender pinnæ; no enlargement.	8	Typical though minute.	....

Norway.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
2 or none.	Large branchiæ in those devoid of opercula, no enlargements at tips.	7	Typical.	Ova and sperms?

Naples.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles. Basal web.	Remarks.
Absent.	Large sausage.	10	About 10 or 12 serrations.	Ova.
....	„ „	9	....	Embryos.

Dongonad, Red Sea.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
2nd December.				
None.	Pigmented, some tips enlarged.	6	Basal web, 8–9 teeth (typical).	Buds in a few.
2nd February.				
None.	Tips of branchia slightly enlarged both in young and adults.	6	Typical.	No buds.
May.				
None.	„ „	6	„	Many buds.
September.				
None.	.....	....	....	Young examples.

Madras Harbour.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
None.	Tips slightly enlarged.	7–8	Typical.	....

Sydney Harbour.

Opercula.	Branchiæ.	Anterior bristles.	Collar-bristles.	Remarks.
None.	Pigmented branchiæ, no enlargement.	9	Typical.	Young had eight thoracic bristles.

(*c*) Structural.

In British Seas *Filograna implexa* has been at intervals under examination since 1863, and it was its structure that year in St. Andrews Bay which showed how closely it approached Prof. Huxley's *Protula dysteri*. Indeed, two years after, the English author admitted to the writer that there was no real distinction between them. Since that time numerous specimens from the east and west, north and south, from shore and from deep water, and from such localities as Norway, Shetland, the Hebrides, several stations (7) in the North Sea, Plymouth, the Channel Islands, the trawling-grounds of 1884, the deep water off St. Andrews Bay, the Moray Frith, the stations of the 'Porcupine,' Naples, the stations of the 'Triton' and 'Knight Errant' from the Red Sea, India, Africa, Australia, and the French coast, &c., have given a fair field for observation, especially when supplemented by living specimens.

Fresh examples from Plymouth in sea water, as Huxley and others truly said, resemble corals in so far as the branchial fans of the annelids project from the tips of the tubes as miniature flowers, the distal parts (branchiæ) of

which are pale greenish yellow, and the anterior region of a fine reddish hue which tints the cephalic region at the base of the branchiæ and passes a short distance along each filament. When eggs are present the posterior region is also reddish, the colour of these being of a brighter hue than the front. Two dark eyes occur on the dorsum of the reddish cephalic area. The anterior (thoracic) membrane is more deeply tinted in front than behind. When in full vigour the pure white of the calcareous tubes, the scarlet of the anterior region which just projects beyond them, and the pale greenish-yellow fans with their opaque tips make a picture at once beautiful and characteristic. The filaments of the branchiæ, when fresh, show under a low power a distinct moniliform arrangement of granular dots in all the British forms along each side—indicating a less developed stage of the more highly organized condition in the Mediterranean form—*Salmacina œdificatrix*. These granular masses are situated on the outer aspect of the interpinnate spaces, and are prominent in a face or a lateral view. The tips of the branchiæ are in all more or less cylindrical, and under a lens present a whitish opacity. The expanded branchial fan is even more beautiful than that of *Alcyonium* from the larger size and greater richness of the filaments and pinnæ. The separate filaments are often curved toward the mouth, approximated, expanded or drooped on one side, the movements in the absence of irritation generally being slow. When touched with a needle, however, the entire fan shrinks into the tube, and though it by-and-by unfolds it may sharply retract several times spontaneously as if in remembrance of the contact of the foreign body. The collar is often folded backward over the tip of the tube when the branchial fan is expanded. A separate branchia retains vitality for a considerable time and the pinnæ move as in the perfect fan, the tip of the filament also bending inward as if carrying out its usual functions, the whole occasionally rolling together like a ball and again expanding. The funnel-like aperture leading to the mouth is richly ciliated, and so with the anal groove posteriorly. Cilia also occur at the bases of the feet.

On arrival at St. Andrews those from Plymouth expanded their branchial plumes freely, and after the first two days various examples dropped from their tubes to the bottom of the vessels, and this continued during several weeks. The extruded forms quietly expanded their branchiæ on the bottom of the vessels, the filaments bending inward now and then and again being expanded, whilst those with long

posterior regions occasionally curved them as the body contracted—with or without a jerk. Fragments of the anterior region with the branchiæ survived a week or more, the movements of the branchiæ being similar, and even a cephalic region with the branchiæ had almost equal vitality. The distal process of the branchial filament is not ciliated, but a rich coating of cilia occurs on the inner surface of the pinnæ.

In reviewing the various examples from the diverse localities it is found that the mass of calcareous tubes—the vermidom, as Huxley called it—is identical in all, though two conditions may be distinguished, the solitary and the social. The tubes from deep water are large, yet light, masses, which invariably, as Dalyell observed, are honeycombed by spaces which permit the free passage of water and enable the annelids to expand their branchial fans in secure retreats. Therein they differ from the solid masses of the aporous corals, for instance, which lack the intricate chambers and which can only expand their polyps on the surface and sides. In some a distinct widening of the lip of the tube occurs, after the manner of a trumpet—a condition perhaps less frequently seen from their extreme brittleness.

The general size of the adult annelids does not offer much variety, though the Neapolitan examples, such as *Salmacina œdificatrix*, are pre-eminent.

The branchiæ vary considerably in their total length, in the length of their pinnæ, in the presence or absence of terminal enlargements to the filaments, and in the development of the paired glands at the base of the pinnæ. Moreover, the presence of opercula characterizes certain forms, yet they are not altogether confined to northern examples, since they are abundant in those from the Channel Islands and off Cape Sagres in the south of Spain. Opercula are absent from the Mediterranean examples, those from Plymouth, those from Madeira, India, and Australia, yet they are equally absent from swarms off St. Andrews Bay. So much has been made of the presence or absence of opercula that it is interesting to find that the enlargements at the tips of the filaments seem to take their places, for instance, at Naples and Plymouth. Where an operculum is present, as a rule no enlargement of the tips of the filaments occurs. The opercula may be comparatively large and thin, or less expanded as circular discs. But the most important fact is that on the same ground, as in Shetland, the Moray Frith, and St. Andrews, some in the same masses have and others do not have opercula. Thus in

swarms of those devoid of operenla from the neighbourhood of the Bell Rock a few were found with them. That fact would seem to dispose of the importance of the operculum as a specific distinction, for the animals are otherwise identical. In the same way some on the same masses from the North Sea had an operculum as an exception, and though Sars described the Norwegian representative as having an operculum, others lately examined from the same region had none. The varying size and shape of the operculum, and the remarkable susceptibility of the branchiæ themselves to change in filaments, pinnæ, terminal region, and glands, suggest the instability of a character derived from the operculum in *Filograna*.

The tips of the filaments, like the branchiæ as a whole, present equal response to external or internal influences. The maximum change, independently of the formation of an operculum, so far as at present known, is observed in the Neapolitan type—*Salmacina œdificatrix*,—in which the non-ciliated tip forms an elongated sausage-like process, though it is probably flattened. No operculum is developed in this type. Similar, though smaller, enlargements take place in the Plymouth and southern non-opercular forms, and which, though not specially noted by Huxley, were alluded to by Claparède. De Quatrefages supposed that in Huxley's *Protula dysteri* these enlargements corresponded to the ovigerous opercula of the Spirorbids.

In those with opercula from the French coast, the Channel Islands, Shetland, and Norway, no enlargement of the terminal region of the filaments, as a rule, was present. Only in certain examples from the North Sea modified opercula and terminal enlargements of the filaments occurred. Thus in an example with eight pairs of anterior bristles one dorsal filament had a somewhat thick terminal process, rather abruptly bevelled on one side, whilst the other filament had advanced a stage further—the clavate tip being unequally bevelled and hollowed so as to form a rudimentary operculum. On the same ground (455 metres) another had the tips of the filaments more irregularly enlarged as flattened lobate processes in every instance, and in several the expansion passed down the filament for some distance. Others showed similar enlargements at the tips of the branchiæ and no opercula, and a third series presented a minute flattened or slightly saucer-shaped operculum on each dorsal filament which could have been of little use as a protection. At other stations the forms of the opercula varied from the thin translucent, more or less circular or hoof-shaped cup to a

long vase with a tapering process on the lip, or the filament had a blunt clavate tip or a cone at the end. In another instance (197 metres) in which no operculum was present the tips of the two dorsal filaments were simply flattened and wider than the rest. Accompanying the foregoing were several—it may be young forms—in which the tips of the filaments were short and little tapered. The presence or absence of opercula, indeed, would appear to depend on no reliable data.

Variability is not confined to the tips of the branchial filaments, for the pinnæ are short as in the young budding forms from Plymouth, or of great proportional length as in certain forms from the North Sea, the branchial fans of which, moreover, are about half the length of the body. The pinnæ of these are much longer and more slender than in any from Plymouth, though the age of the specimen has considerable influence in this respect.

The number of the bristle-tufts in the anterior region is likewise variable—ranging from five to ten, though a considerable majority show seven, the number most frequent in the north.

The first pair of bristle-tufts, the collar-bristles, diverges from the others in size, direction, and structure, and in these respects is closely allied to the condition in *Spiorbis*. Those from Plymouth may be taken as the type, the first pair of bristle-tufts being conspicuous organs directed forward, upward, and outward. The shaft of each bristle is nearly cylindrical, diminishing a little when viewed from behind toward the commencement of the wing, and the tapering axis can be followed as distinct from the wing to the hair-like tip. The broad basal part of the wing has numerous (about a dozen) serrations, sloping from the base to the distal end in lateral view, then a hiatus occurs, followed by a minutely serrated tapering wing or blade. Certain views point to the double nature of the basal expansion of the wing. In some from St. Andrews several of the bristles of this tuft do not show the gap separating the more boldly serrated base from the minutely serrated terminal region of the wing. Moreover, a few simple tapering bristles without an evident wing were present. How far these may consist of developing forms has yet to be ascertained, but such is unlikely. These bristles are freely moved forward, outward, and inward for various purposes, and when feeble or dying they stand stiffly forward and outward. In the buds these bristles show the same structure, and slight hollows at the site of the gap between the basal and distal parts of the wing indicate the notch.

The second tuft has bristles with simple wings. The rest of the tufts in the anterior region have, in addition to the simple winged bristles, two or more with sickle-shaped or falciform tips, and in the ordinary preparations (microscopic) these are posterior. These tips are translucent and flattened, widened at the end of the shaft, characteristically curved and tapered to a fine point.

The bristles of the posterior region are few in number in the groups, and follow a blank space behind the anterior region. Though smaller, the structure is the same as the simple winged forms. The wings on the slender bristles of the last three or four segments are very narrow—just visible in living examples.

So far as can be ascertained, the hooks in the various forms correspond in intimate structure.

Though the Polychæta as a rule are unisexual, various hermaphrodite annelids are known; thus H. Parlin Johnson gives a list of sixteen or seventeen species possessing this character. No form, however, is more interesting than *Filograna* (Salmacinæ) which not only is hermaphrodite, but reproduces also by budding, as first pointed out by Huxley. In the hermaphrodite annelids, as Malaquin clearly observes, the male and female gonads may be quite distinct, as in the Nereid *Lycastis quadraticeps*, Gay, or they may be mixed, as in *Ophryotrocha puerilis*. In the Salmacinæ and Spirorbids, on the other hand, the male and female gonads are in different segments.

The budding in *Filograna*, as Sars noticed, takes place in the posterior region of the adult, viz., where the long paired bristles occur—six or seven of these being in front of the bud, which is formed of the caudal region of the nurse-stock with the vent and its two papillæ.

The early buds are ovoid and granular, wider than the ordinary caudal region, with nine or ten pairs of bristle-tufts characteristic of the posterior region, the anterior division being devoid of them, but having simple smooth filaments representing the branchiæ. No special differentiation of the granular interior of the bud can be made out, further than a more opaque granular wedge in front of the anal papillæ, and which probably represents the adult rectum. No trace of the collar is at first visible, then a fold, probably the ventral, occurs at the base of the short filaments.

In the next stage the body of the bud is more elongated, the bristled segments are more numerous, and a streak along the middle line leads to the vent, and is in contact anteriorly with the alimentary canal of the adult, which in one contained a large foreign mass about its middle. The branchiæ

(four on one and three on other side) are longer and more slender, and are distinctly moniliform. A rounded process behind them on each side represents the lateral lobes of the collar, and a slightly opaque curved area on the anterior region probably indicates the alar membrane.

The buds appear to leave the nurse-stock when six pairs of anterior bristles are present, viz., the first pair which project horizontally and five behind these, the alar membrane being narrower behind than in front, and developing from before backward. The branchial filaments have pinnæ and terminal processes. The body is comparatively short and wide, the anterior and posterior regions being nearly equal in length. A part devoid of bristles occurs behind the anterior region, then follows ten or eleven bristled segments and a caudal region devoid of bristles.

In many from Plymouth the anterior part of the posterior division, the seat of the male elements, is marked by numerous closely arranged transverse lines apparently due to transverse rows of minute red pigment-granules on the stomach; yet in these the male elements at this date (8th June) had not attained great development, the ovigerous region behind being considerably in advance, as might be anticipated in view of the presence of the ova in the early bud. A portion of the tail, consisting of a variable number of segments (12–15 or more), being free from reproductive elements and presenting only the greenish blood-vessels of the gut and the feet. The contrast, therefore, between such specimens and those forwarded in March, in which month the reproductive elements were inconspicuous, though buds were numerous, was pronounced. In June, again, the budding forms had reproductive elements developed only in the bud, the reddish hue of which betokened the early ova, only a median greenish stripe, broad at the vent, indicating the alimentary canal in the bud ready to separate. Such subsequently developed a caudal region of numerous segments.

No uniformity appeared to exist as to the segment of the posterior region from which the bud sprung, for example, six, seven, eight, nine, and ten bristled segments occurred in a series in front of the bud.

The sperms frequently develop in the forms from Plymouth a little later than the ova, none indeed appearing in the bud, but by-and-by they fill the non-bristled region in front of the ovigerous segments and bulge laterally, the region being thus characterized by its pallor.

On the other hand, a short example having about twenty-five segments in the posterior region had only male elements in front of a part, containing thirteen segments and the

pygidium. The achetous region (of four or more pale segments) was filled with sperms—some ripe, the majority scarcely ripe. The sides of the posterior region, which would by-and-by form the bud, had opaque cells and granules (developing ova?). The sperms thus first attained maturity in the example. This, therefore, shows the variable nature of the form in this respect.

On the 9th June early trochospheres of a deep red colour occurred in the vessels, the prototroch being conspicuous at each side. These simply rotate or swim in small circles; but the larvæ with commencing segmentation dart through the water with great vigour, and often in a straight line, whilst others made larger circles near the bottom. One of the latter had three segments behind the head, and in all two eyes were distinct.

The mode of development in these forms thus differs from that observed in the preparations of *Salmacina œdificatrix*, which produces large ova and trochospheres in the tube. No buds have been met with.

(*d*) General.

Filograna in itself demonstrates the difficulties which surround the idea of special creation as an explanation of the diverse conditions of structure and reproduction, since those with and those without opercula, those with enlarged tips to the branchiæ and those without them, those with eyes and those devoid of them, those with a few pairs of anterior bristles and hook-rows and those with an increased series of both, and other variations occur on the same site. It is more reasonable to believe that the observer is dealing with a species spread over the whole globe, and which is endowed with a capacity for variation almost unequalled in the animal series, than to adhere to the view that there are separate species or genera.

The sea is in a different position from Mr. Alfred Wallace's view of the land, where "so long as a country remains physically unchanged, the numbers of its animal population cannot materially increase. If one species does so, some others requiring the same kind of food must diminish in proportion." In the sea such strictures, perhaps, are less necessary, for there is an ample margin for every living form in so far as food is concerned. It is true "the numbers that die" (or are killed) "annually must be immense; and, as the industrial existence of each animal depends on itself, those that die must be the weakest—the very young, the aged, and the diseased; while those that prolong their existence can only be the most perfect in health and vigour—

those who are best able to obtain food regularly, and avoid their numerous enemies." It is difficult, however, to see how such an argument can apply to sedentary zoophytes which are browsed on by young cod, to the living corals which are crushed by the *Scari*, or to the sedentary Polychæts in calcareous tubes which are devoured by Echini and various fishes. It would be interesting to find out in these the "struggle for existence in which the weakest and least perfectly organised must always succumb." There is little competition in a colony of *Filograna*, or in that of *Obelia*, and it can hardly be said that there is a struggle for existence in such reef-corals as *Polythoa* or *Zoanthus*.

Checks there must be on the extraordinary powers of propagation shown by *Filograna*, else the ocean would swarm with masses like coral-reefs, yet individual competition must be slight, since post-larval forms secrete their tubes, it may be, on new sites, whilst the buds may increase the parent mass of tubes on the old one. Each is perfect and capable of "performing the different acts necessary to its safety and existence under all the varying circumstances by which it is surrounded," and "perfect acquaintance with its organization and habits" would hardly enable us "to calculate the proportionate abundance of individuals which is the necessary result." It cannot be said that the inhabitants of the sea are "kept down by a periodical deficiency of food," though other checks exist. It is difficult also to explain the comparative abundance, say, of *Filograna* or the scarcity, say, of *Placostegus* as due to their organization and resulting habits, "which, rendering it more difficult to procure a regular supply of food and to provide for their personal safety in some cases than in others, can only be balanced by a difference in the population which have to exist in a given area."

If it be supposed that the ancestral form was devoid of an operculum, and that the presence of that organ in one form or another is a variation, the question as to its influence on the welfare of the species naturally suggests itself. Can the thin, almost membranous, operculum so guard the aperture of the tube as to be a decided advantage to the occupant—in contrast with the bare tips of the branchiæ or their enlarged extremities, which otherwise block it? The indiscriminate occurrence, in the same colony, of opercula, enlarged tips, and ordinary tips, would point to the view that the development of one or other of these is of secondary moment; yet it must be borne in mind that in certain northern localities the majority follow one condition or another, and that such races as *Salmacina œdificatrix* are characteristic of the

warm Mediterranean waters. Environment would thus appear to be a factor of importance in some instances, if not in all. Moreover, it would seem to be as unnecessary to place the weight given by some authors on the presence or absence of an operculum as to separate like species of oxen by the presence or absence of horns. Some, like Claparède and Fauvel, perhaps, might be disposed to separate as distinct species those with and those without an operculum, or to regard either as a sudden and an important mutation in a given series. It may, indeed, be asked why *Filograna*, with such a tendency to variation in the organs mentioned, as well as in reproduction, has not developed along the lines indicated and produced descendants in which each variation fitted it to survive more readily than its fellows—whether as regards its somatic cells or its germ-cells, both of which are affected? The continuity of the germ-plasm does not appear to restrict the variations indicated, even in reproduction, since there may be free ova, internal embryos, or buds. A study of karyokinesis in the sexual cells might, perhaps, aid in solving the problem, though this is conjectural.

Again, the variability in the number of the anterior (thoracic) bristles is a feature seen in not a few Polychæts —for instance, in the Sabellids. In *Potamilla reniformis*, O. F. M., the anterior bristles may range from five to twenty-six pairs, a much wider variation than in *Filograna*. Certain races of *Filograna* have seven pairs, others from seven to nine, whilst the Neopolitan types may reach ten. Such is not necessarily the effect of age, but rather of environmental conditions—for example, the general temperature of the surrounding water, the rich supply of nourishment, and the abundance of light.

In considering the differences in structure presented by *Filograna* the variations in the tips of the branchiæ occur under such diverse conditions, as well as on precisely the same site and under the same conditions, that one is at a loss to say wherein the process of selection and the "struggle for existence" lie. Their tubes give the necessary protection, so that the species can vary in any manner in which its inherent capacities permit, and a single generation may afford examples of change in the organs referred to. The enlarged tips of the branchiæ are of a glandular character, and thus differ from the opercula—though borne by the same parts. Moreover, it cannot be said that disuse has caused the disappearance of the opercula, since the forms devoid of them have as much need of them as before. The bright pigment of the branchiæ shows that light, as well as

aeration, plays an important part in the economy of the annelid.

In such a type as *Filograna* it is not the hard-and-fast rule that "like begets like," but the inherent tendency to vary in every particular in the parts indicated is the main factor. It is questionable if, with every care, the production of those with opercula or those with the greatly enlarged tips to the branchial filaments could always be relied on by breeding from suitable parents of each type, unless the exact surroundings are obtainable, since the tendency to variability is so intense. It is said that varieties replace the original species because they are "more perfectly developed and more highly organised, and in all respects better adapted to secure its safety, and to prolong its individual existence and that of the race. Such a variety *could not* return to the original form; for that form is an inferior one, and could never compete with it for existence. Granted, therefore, a 'tendency' to produce the original type of the species, still the variety must ever remain preponderant in numbers, and under adverse physical conditions *again alone survive*" *.

Whilst many examples of the foregoing statement may be found in the higher vertebrates, the case of *Filograna*, for instance, does not seem to fall into line, for here are variations so numerous in structure and development and so intermingled with each other that it is difficult to say which is the original form and which the variation, since all forms may be found under like conditions. In this connection it may be asked what variety of *Filograna* has a tendency to maintain its existence longer than the original species or longer than any other variety? Can it be said that those with opercula are better fitted to survive than those devoid of them, or that those with the distal ends of the branchial filaments enlarged into sausage-like masses supplant those without them? Are those with eyes and nine pairs of anterior setigerous processes enabled to continue the species more effectively than those which have no eyes and only five or six setigerous processes? There is no proof that any of these is in a better position than another—yet Nature does nothing in vain; the facility with which variations occur and the vast distribution of the species would lead to the belief that a clue may yet be found to unravel the mystery. The species certainly fluctuates to and fro in regard to the organs mentioned, but does not progress along any of the lines

* This and other quotations are taken from the important papers of Mr. Darwin and Mr. Wallace in the Proc. Linn. Soc. vol. iii. no. 9, 1858.

with sufficient continuity to evolve anything more than a variation.

The differences in the various races of *Filograna* do not appear to be so great as to warrant specific separation, and this is the more noteworthy in a species so widely distributed and so plastic. The variations lead to no change of habit or surroundings, no essential change in general structure, and the different methods of reproduction remain more or less the same throughout. No variety seems to excel the other in its influence on the stability of the species, or to lead to fixity and the formation of a new species, and the "extermination of the older and less improved forms." This species does not conform to the view that the "lesser differences characteristic of varieties come to be augmented into the greater differences characteristic of species" *. If the struggle for existence held in the ordinary way, it is reasonable to suppose that certain variations of structure and development would have been singled out as permanent —to the exclusion of others.

The differences between the varieties of *Filograna* are more pronounced, perhaps, than in such a case as A. G. Mayer's *Eupenthesis folleata* and *Pseudoclytia pentata*, the former with the typical four, and the latter with five radial canals, gonads, and manubrial lobes. The Cœlenterates, moreover, have a more simple structure, and their gelatinous tissues respond more easily to sudden variations.

Whilst there is wide variability in the plastic branchiæ, eyes, opercula, the number of "thoracic" segments, and the absence or presence of buds, there seems to be more or less uniformity in the structure of the bristles and hooks as well as of the tubes from pole to pole of the world. It may well be asked why the environment has not altered these organs (bristles and hooks)? Their functions, it is true, have not altered, but neither have the functions of branchiæ or opercula.

Yet, after all, and taking a broad view of the species, *Filograna* remains the same, and leads to no other type, for the Spirorbids, which have similar collar-bristles and branchiæ, are joined by no intermediate forms, their tubes are coiled and massive, and their opercula larger and calcareous. No change of surroundings in the varied waters stretching from Arctic to Antarctic seas makes the species other than *Filograna*. Moreover, there does not seem to be any correlation in the parts which vary, even the absence of the opercula and the presence of the enlargement of the tips of the branchial filaments are by no means

* Darwin, 'Animals and Plants under Domestication,' vol. i. p. 7.

invariable. In the Neapolitan *Salmacina ædificatrix* many specimens would seem to show shorter and more slender pinnæ on the filaments, which throughout are terminated by the enlarged cushions.

The higher Polychæts, as a rule, have the sexes separate, but *Filograna* is hermaphrodite, and, moreover, increases by active budding, the buds rapidly developing sexual elements which may be shed or the ova may be fertilised internally and find exit as larvæ. All these processes exist, it may be, in one and the same colony, and it is not easy to explain why such diversity should occur, or why such characters, if acquired, should not be more stable.

There is little evidence of a struggle for existence in such a form, since the sea supplies at once food and calcareous matter everywhere ; yet the warmer waters appear to favour the development of larger processes at the end of the branchial filaments in certain cases, but this falls under environment rather than individual competition, for it cannot be supposed that the great size of these processes is necessary for the well-being of the species generally. Whilst they may be associated with the environment, yet under the same conditions small terminal processes may be present, just as in colder waters operenla may be present or absent in the same colony. In connection with the statement that the warmer waters seem to favour rapid spread of the species it need only be pointed out that, in contrast with the colder eastern waters of Scotland, *Filograna* flourishes luxuriantly in the genial waters of the Laboratory at Port Erin and speedily blocks with its calcareous tubes the supply-pipes, whilst on the boats of Dongonab in the Red Sea it is equally, if not more, luxuriant.

Sexual selection would appear to have little or no effect in producing the varieties, though special varieties of opercula or branchiæ on a given site may owe their frequence to the qualities transmitted by parents, or by the process of budding from a nurse-stock.

The coloration of the branchiæ is a feature of moment, especially in connection with the incidence of light. This coloration is marked in the Australian forms and in those from the Red Sea, the Mediterranean, and the south generally, though it is by no means inconspicuous in those of colder climes. Is this coloration protective where it is highly developed, or is it only ornamental? The great beauty, as well as the endless variety, of the branchial circles or fans of the Serpulids must have struck every marine zoologist, and therein *Filograna* agrees with its family ; but the pigment may have special physiological purposes to

perform, seeing that the cœlomic fluid is present in every branchial filament.

The effects of inbreeding can hardly affect the reproductive processes of this species, since the sperms are widely distributed in the water and fertilise, it may be, different ova either in the cœlom or in the free condition, whilst the buds form a further check of importance. Notwithstanding the wide range of the sperms shed by such forms in the sea, the question of hybridization does not appear to arise—indeed, no more than in the case of the cod, haddock, and pleuronectids which meet on the breeding-grounds.

Reversion or atavism appears to have little to support it in the case of *Filograna*, though the occurrence of a few with opercula in a race usually devoid of them may be held by some to indicate this feature, especially as the development of this organ seems to be less connected with the environment. If such organs appeared in a bud—that is, independently of sexual reproduction,—it might show that the tissues of nurse-stock and bud were imbued with an inherent continuity of plasm, which in function may remain latent or intermittently burst forth in the formation of such organs, just as the reappearance of coloured longitudinal stripes takes place in young feral pigs. Particular crosses may also favour the appearance or disappearance of opercula, enlarged tips to branchiæ, or other features in succeeding generations: as Darwin says "That a being should be born resembling in certain characters an ancestor removed by two or three, and in some cases by hundreds or even thousands of generations, is assuredly a wonderful fact." As *Filograna* is hermaphrodite the so-called secondary sexual characters have a more direct line of transmission.

Whether the variations noted are hereditary is still an open question, though it would appear that in some cases at least these are not sufficiently stable to lead to the formation of species. Certainly *Filograna* is under "conditions of life incessantly inducing fresh variability" (*Darwin*), and thus, perhaps, has a check to inheritance in the ordinary sense of the term. Perhaps the species falls under the group in which selection has not been applied, and thus distinct races or even species have not been conspicuously formed; certainly it is difficult to see how natural selection affects *Filograna* to any extent. The variability in this species is not due to crossing, food, climate, or inbreeding. It is inherent.

2. *On* Harmothoë watsoni, *M'I., an var.* H. marphysæ, *M'I.*

Whilst studying the structure and habits of *Lagis koreni*, Malmgren, forwarded from Lanfairfechan, in North Wales, Mr. Arnold Watson found a Polyroid as a commensal in the tube of an adult annelid and he kindly sent it for examination along with some remarks on its condition in life. It measured about one-fifth of an inch in length, with white scales bearing reddish-brown markings, which at their interior ends joined to form crescents. Anteriorly was a red disk, probably due to the cephalic ganglia. The median tentacle was long, and one anal cirrus was seen, though most of the dorsal cirri had been shed.

No scales remained on the body which had a fairly regular outline from the even disposition of the feet. The head is less elongated than in *Harmothoë marphysæ*, and in the preparation retained a pale brownish hue, with the usual median groove enlarging at the anterior peaks. The presence of these anterior peaks, which the dark pigment at the base of the median tentacle more clearly differentiates, the large size of the eyes, and the shorter head distinguish this form from *H. marphysæ*. All the eyes are visible from the dorsum, though the anterior pair, from their slightly lateral position, are less distinct than the posterior pair, which lie in front of the nuchal border. The anterior eyes are somewhat in front of the middle of the head, and thus separated from the posterior pair by a considerable interval, whilst they are also more distinctly lateral. Both pairs are, however, visible in a lateral as well as in a dorsal view, and all are of medium size, considerably larger than those of *H. marphysæ*. The median tentacle is long and furnished with clavate papillæ. The lateral tentacles are inferior and in the preparation have slightly enlarged or probe-shaped tips. The palpi are of moderate length with tapered extremities, and their surface is smooth. The tentacular cirri are comparatively short and have slender tips, whilst the surface has a few clavate papillæ.

The body is normal in shape, and thus differs from that of *H. marphysæ*, being slightly narrowed in front and more distinctly diminished posteriorly. The number of bristled segments is about thirty. When the scales are removed, a translucent bar, the proboscis, appears behind the head. The feet have a regular arrangement from front to rear, and the pale bristles project beyond them with similar regularity. A typical foot presents dorsally the cirrus, which is enlarged at the base and tapered distally, with numerous clavate papillæ. The tip of the organ does not project much beyond

the bristles, and thus appears to be somewhat shorter than in *H. marphysæ*. A slight eminence below the cirrus gives origin to the pale dorsal bristles which radiate from it in a fan-like manner, but when compressed laterally show a shorter, stouter, upper, and a longer, more slender inferior series. The upper shorter forms are boldly curved and serrated on the edge. The more slender inferior bristles are less curved and the serrations on the hair-like tip are minute. A spine pierces the lower margin of the elevation from which the bristles emerge—in lateral view. These bristles thus closely resemble those of *H. marphysæ*, differing only in the more minute serrations of the tips and their smaller size. The inferior division of the foot forms a cone with a pointed tip, up to the base of which the powerful spine goes. Its dorsal outline is sinuous, the ventral convex (in lateral view), the outline thus differing from that of *H. marphysæ*, though the size in the respective cases has to be remembered. The upper two have elongated simple tips with only a slight swelling above the shaft and very minute serrations on the edge. Those in lateral view are above the spine. Those below the spine have shorter tips, longer rows of spikes, and bifid tips, and the swelling above the shaft is more distinct. The short ventral cirrus has an enlarged base which rapidly tapers to a slender tip, and its surface has a few clavate papillæ. Posteriorly all the parts of the foot are diminished, and the bristles are proportionally more slender and elongated.

The scales have the colour mentioned by Mr. Arnold Watson, and a similar outline to those of *H. marphysæ*, but they are thinner and more translucent ; moreover, in some no papillæ can be observed. In other scales the papillæ, from ten to twenty in number, form a small compact group on the thinnest margin of the scale and about its middle, whereas in *H. marphysæ* these papillæ stretch in the adult female as a long band to the angle of the thin edge. The changes here indicated may be the result of growth, but there is a decided divergence.

On the whole, this Polynoid closely approaches *H. marphysæ*, but the structure of the shorter head with its larger eyes, and the closer approach of the anterior to the posterior pair, the slight differences in the structure of the feet and the bristles all combine to cause hesitation. Intermediate examples, however, may yet enable future observers to unite them. It is an interesting fact, however, in connection with the ripe *H. marphysæ*, that a marked change in the condition of the feet accompanies reproduction, though the eyes remain as minute as before.